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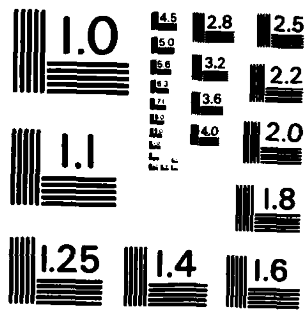

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AN EVALUATION METHODOLOGY
FOR FACILITY ENERGY CONSERVATION
PROJECTS

October 1982

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Since establishing the Energy Conservation Investment Program (ECIP) in 1977, the Department of Defense has expended about $750 million on projects proposed by installations to conserve utility energy. Each proposed project was analyzed to determine such parameters as life cycle cost (LCC), savings to investment ratio (SIR), energy savings to capital cost ratio (E/C), etc., and then ranked against all "completing" energy conservation projects to develop funding priority. A certain lack of rigor in analysis and ranking was not

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critical because the funds required and the funds available were approximately equal.

Two factors have arisen that make more rigorous analysis and more careful ranking necessary. First, the sum of estimated costs of all proposed projects exceeds the funding available. Second, the Federal Energy Management Program (FEMP) requires all executive agencies to use an LCC analysis technique promulgated by the Department of Energy (DOE) to determine which projects are to be funded. Thus, DoD must incorporate this method into its ECIP analysis and ranking techniques.

The report presents an improved financial analysis method--IFAM-- for use in ECIP which fulfills all the FEMP requirements. IFAM employs a microcomputer with user-friendly software to analyze and rank projects. Inputs to IFAM are both general--GNP deflators, DOE energy cost escalation rates, OMB-authorized federal discount rate, etc., and project-specific--estimated capital and operational cash flow, schedules, local utility energy costs, etc. Only the project-specific inputs are required from the proposing installation. Analysis takes place at a central analysis center where general and project-specific inputs are entered on an electronic ledger "spread sheet." Using IFAM, the analysis center produces a most likely value for financial parameters of interest--LCC, SIR, E/C, etc.--and ranks competing projects by the desired parameters. A sensitivity analysis and an uncertainty analysis capability are embedded in the IFAM software.

The reports recommends that the Deputy Assistant Secretary of Defense (Installations) encourage IFAM's use in the next available ECIP cycle on a pilot basis by one major command or facilities engineering division of each Military Department. If that test proves IFAM to be an effective, efficient ECIP analysis tool, the report further recommends that it be used for all ECIP analyses and that it be considered for financial analysis in other DoD energy- and construction-related programs.

EXECUTIVE SUMMARY

Since establishing the Energy Conservation Investment Program (ECIP) in 1977, the Department of Defense has expended about $750 million on projects proposed by installations to conserve utility energy. Each proposed project was analyzed to determine such measures as life cycle cost (LCC), savings to investment ratio (SIR), energy savings to capital cost ratio (E/C), and then ranked against all "competing" energy conservation projects to develop funding priority. Rigor in analysis and ranking was not critical because the funds required and the funds available were approximately equal.

Two factors have arisen that make more rigorous analysis and more careful ranking necessary. First, the sum of estimated costs of all proposed projects exceeds the funding available. Second, the Federal Energy Management Program (FEMP) requires all executive agencies to use the more demanding LCC analysis technique promulgated by the Department of Energy (DoE) to determine which projects are to be funded. Thus, DoD must incorporate this method into its ECIP project selection technique.

We have developed for use in ECIP an improved financial analysis method--IFAM--which fulfills all the FEMP requirements. IFAM employs a microcomputer with user-friendly software to analyze and rank projects. Inputs to IFAM are both general--GNP deflators, DOE energy cost escalation rates, OMB-authorized federal discount rate, etc.--and project-specific--estimated capital and operational cash flow, schedules, local utility energy costs, etc. Only the project-specific inputs are required from the proposing installation. Analysis takes place at a center where general and project-specific inputs are entered on an electronic ledger "spread sheet." Using IFAM, the analysis

center produces a most likely value for financial measures of interest--LCC, SIR, E/C, etc.--and ranks competing projects by the desired measures. A sensitivity analysis and an uncertainty analysis capability are embedded in the IFAM software.

We recommend that the Deputy Assistant Secretary of Defense (Installations) enlist the cooperation of the Military Departments in a pilot test of IFAM in the next available ECIP cycle. If that test proves IFAM to be an effective ECIP analysis tool, we recommend that it be used for all ECIP analyses and that it be considered as a financial analysis method in other DoD construction-related programs.

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1. INTRODUCTION

Department of Defense (DoD) installation energy costs are growing in real terms, and the future rate of that growth has become increasingly uncertain. Economic analyses of prospective installation projects have thus become mandatory and more complex. When projects consume substantial amounts of energy during their lifetimes or when they conserve or shift energy sources, the combined effects of inflation and energy price escalation make future costs used in these analyses more uncertain. Planning for new or replacement facilities must take into account uncertain future costs, as well as initial acquisition costs.

This report presents a method for performing economic analysis of proposed facility energy projects under the DoD's Energy Conservation Investment Program (ECIP).

LIFE CYCLE COST

As indicated in Table 1-1, the relative percentages of the construction and operational phases of a system's Life Cycle Cost (LCC) vary widely, but in general over one-half of a system's LCC occurs in the operational phase. Thus, an economic analysis of a proposed project will be meaningful only if acquisition and ownership cost calculations are accurate and complete.

TABLE 1-1. FACILITY LIFE CYCLE COSTS

Construction	28-54%
Operation and Maintenance	45-60%
Replacement and Modernization	5-10%
Salvage and Disposal	0-1%

Source: Dienemann, P.F., "Life Cycle Cost Analysis Methodology for Construction Projects." F. R. Harris, Inc., report for Royal Commission of Saudi Arabia, Contract No. SGC-02-1397, October 1978.

LCC analysis should be performed when any construction, refurbishment or energy conservation project meets one or more of the following conditions:[1]

- the anticipated energy costs of the facility, system, or purchase are expected to be large throughout its life;
- the facility, system, or purchase has a long, physical lifetime;
- the increased efficiency of maintenance will have a significant impact on overall costs;
- the investment is large;
- the post-purchase costs are significant.

Six steps generally are recognized in the economic analysis of a proposed energy investment:

1. Identify alternative approaches to achieve objective.
2. Establish a common time basis for costs and study period.
3. Identify and estimate benefits and costs.
4. Convert cash flows to a common time.
5. Compare alternatives based on relative economic efficiencies.
6. Perform risk and/or sensitivity analysis.

The method presented in this report covers all steps of the analysis except the first. Once the engineering alternatives are established, the method will either facilitate or directly perform the remaining steps.

ENERGY MANAGEMENT IN THE FEDERAL GOVERNMENT

Federal Energy Management Program

The Department of Energy (DOE) is responsible for establishing energy conservation regulations and monitoring the energy conservation performance for all executive agencies, in accordance with public law and

[1] Brown, R. J. and Yanuck, R. R., Life Cycle Costing A Practical Guide for Energy Managers, The Fairmount Press, Inc., Atlanta, Ga., 1980.

executive order.[2] One aspect of this responsibility is to provide a common method of analysis and comparison of the life cycle capital and operating costs of federal energy conservation and renewable energy projects. The "Life Cycle Cost Manual for the Federal Energy Management Program" was promulgated in December 1980 as National Bureau of Standards (NBS) Handbook 135 by the Department of Commerce. It was incorporated into the Code of Federal Regulations[3] in November 1981. The regulation requires the FEMP LCC analysis method to be used to estimate:

- Whether retrofitting an alternative system to an existing Federal building is cost-effective and tends to minimize the life cycle cost of that building;
- Relative cost-effectiveness of retrofit investments in buildings;
- Whether an alternative design for a new Federal building will minimize the life cycle cost of that building;
- Payback time for solar demonstration projects;
- Present value of net benefits or excess costs of a solar demonstration project compared to a substitute conventional non-solar alternative building system in an existing Federal building or in the design of a new Federal building.

Energy Conservation Investment Program

The Department of Defense established ECIP in March 1977 as its primary program for achieving the energy reduction goals for existing facilities which were established by Executive Order 12003. It is a Military Construction (MILCON) funded program for retrofitting existing DoD facilities to make them more energy efficient. The program has expanded to include such

[2]Section 381(a)(2) of the Energy Policy and Conservation Act, as amended, 42 U.S.C. 6361(a)(2); Section 10 of Executive Order 11912, as amended; Title V of the National Energy Conservation Policy Act, 92 Stat. 3275.

[3]Subpart A. Pa 436, Title 10, Code of Federal Regulations.

projects as renewable energy sources and cogeneration. The ECIP program has been effective in accomplishing energy conservation measures that would not have been funded through Base Operating Support funds.

Through FY 1981, the Military Departments spent approximately $750 million for energy conservation improvements under ECIP, as detailed in Table 1-2. During that period, the estimated cost of proposed projects and the funds available were approximately equal. Therefore, although projects were ranked for order of accomplishment, the ranking was not critical. Beginning in FY 1982, however, a backlog of unfunded projects developed and ranking became more significant.

TABLE 1-2. ECIP PROJECTS FUNDING
(Millions of Dollars)

FISCAL YEAR	ARMY	NAVY	AIR FORCE	TOTAL
FY76	30.4	28.8	44.0	103.2
FY77	60.1	52.5	28.1	140.7
FY78	15.6	26.1	31.6	73.3
FY79	52.7	42.9	35.0	130.6
FY80	45.0	46.7	32.2	123.9
FY81	67.4	53.0	45.2	165.6
TOTAL	271.2	250.0	216.1	737.3

The analysis scheme for ECIP projects, in existence since the program's inception, is different from the LCC analysis methods now required by the FEMP. It is a simple system, ignoring some elements of a project's life cycle cost. In keeping with the national policy of the late 1970's, it emphasizes energy (Btu) savings. A comparison of FEMP and ECIP project-ranking guidelines is shown in Table 1-3.

As Table 1-3 suggests, the FEMP LCC analysis is a complete economic analysis and project ranking method. It can be applied not only to energy

TABLE 1-3. COMPARISON OF ECIP AND FEMP GUIDELINES

FEMP	ECIP
A. Required for all energy related construction.	A. Required for only "capital intensive" retrofit projects.
B. All projects must be LCC cost-effective. All LCC cost parameters are included. Based on a savings-to-investment ratio (SIR) >1.0	B. All projects must be cost-effective. LCC cost parameters not included or used differently are design, initial & terminal salvage, and replacement costs. Based on a "simplified" discounted energy savings-to-cost ratio (E/C) > 1.0.
C. Retrofit projects ranked by SIR. New construction ranked by LCC. Solar projects ranked partially by net LCC, payback, and SIR.	C. Retrofit projects ranked by E/C (undiscounted construction working estimate (CWE), first operating year energy savings only). New construction and solar not applicable to ECIP.
D. All annual cash flows are estimated in constant dollars as of the date of study. Base year is fiscal year of study.	D. Annual cash flows are estimated in constant dollars as of the end of the program (day #1 of execution year) by use of short-term escalation factors for all cost and savings categories. Base year is execution year.
E. Seven percent "real" discount rate must be used.	E. Ten percent "real" discount rate must be used.
F. Until marginal utility prices become available, project investment costs occur at the beginning of the base year and must be adjusted downward 10 percent to reflect benefits to society.	F. No mention of marginal pricing or benefits-to-society adjustments. Investment costs occur at the beginning of the execution year.
G. Energy conversion factors are "boundary purchase prices", i.e., 3412 Btu/kWh for electricity.	G. Some energy conversion factors are different from those in FEMP. Specifically, the conversion for electricity is 11,600 Btu/kWh for on-site <u>and</u> "boundary purchased" electricity (for use only in the E/C calculation).
H. Use actual base year fuel prices if available or use DOE prices. Time-of-day pricing and projected escalation rates may be used if provided by supplier.	H. Use actual base year (escalated to execution year) prices for fuel. No time-of-day pricing mentioned.
I. "On-site generated" electricity prices are the higher of actual local purchased electricity or the price of input fuel plus generation and distribution losses. "On-site generated" steam and hot water price is the price of input fuel and generation distribution costs.	I. Price for electricity or steam purchased from on-site sources is the actual average gross energy input to the generating plant plus distribution losses.
J. DOE-provided differential escalation rates must be applied to base year fuel costs for projection of future prices.	J. ECIP-provided differential escalation rates may be used or "where local conditions and experience indicate more valid differential escalation rates," local values may be used.
K. Equivalent study period of mutually-exclusive projects is lesser of 25 years or least common multiple of the estimated lifetimes of the system alternatives. For non-mutually exclusive retrofit projects, use the estimated life of each system up to 25 years.	K. Economic life of all projects must not exceed DoD given values. No mention of mutually or non-mutually exclusive projects.
L. For multiple proposed projects within a building or system, use an iterative SIR and LCC method to eliminate over-estimation of energy and dollar avoidance.	L. For multiple proposed projects within a building or system, "care must be exercised by the analyst" to assure that projected energy savings are not duplicative.
M. LCC rule does not specifically require sensitivity or probability analysis, but FEMP manual recommends and OMB Circular A-94 requires it "if there is a reasonable basis to estimate the variability of future costs and benefits."	M. ECIP does not mention sensitivity analysis but DODI 7041.3 requires risk/uncertainty analysis (cost ranges for estimates).

conservation retrofit projects, but also to new construction, operations and maintenance, and alternate energy projects. It does not include, however, the means to assess economic risk.

We propose remedying that deficiency by building into the basic FEMP LCC methodology a capability for assessing cost uncertainty. The resulting enhanced methodology, which we describe in the rest of this report, would then be suitable for financial evaluation of candidate projects for ECIP and other construction-related programs.

2. AN IMPROVED LIFE CYCLE COST ANALYSIS METHOD

Our improved financial analysis method (IFAM) permits proposed energy projects to be ranked by their expected life cycle cost values and the uncertainty surrounding those values. It fulfills all requirements of the FEMP and of DoD Instruction 7041.3.[1]

OVERVIEW

IFAM is designed to use commercially-available, user-friendly microcomputer hardware and software.[2] It is envisaged for use at a common analysis center, such as a Military Department facility engineering headquarters, a major command, public works center or field engineering division, requiring only project-specific data to be provided by installation personnel. Figure 2-1 provides a summary system flow chart.

Two data files are required, one project-specific, the other general. Project-specific data are obtained from the proposing installation. An installation input form is at Appendix A.

The general file contains such data as the discount rate designated by the Office of Management and Budget (OMB) for use in the financial analysis of federal projects, the DOE projection of costs for electricity and fuels (e.g., No. 2 heating oil, No. 6 residual oil) in all DOE Regions, the end-use energy conversion rates for all fuels, etc. These data will be provided by higher headquarters.

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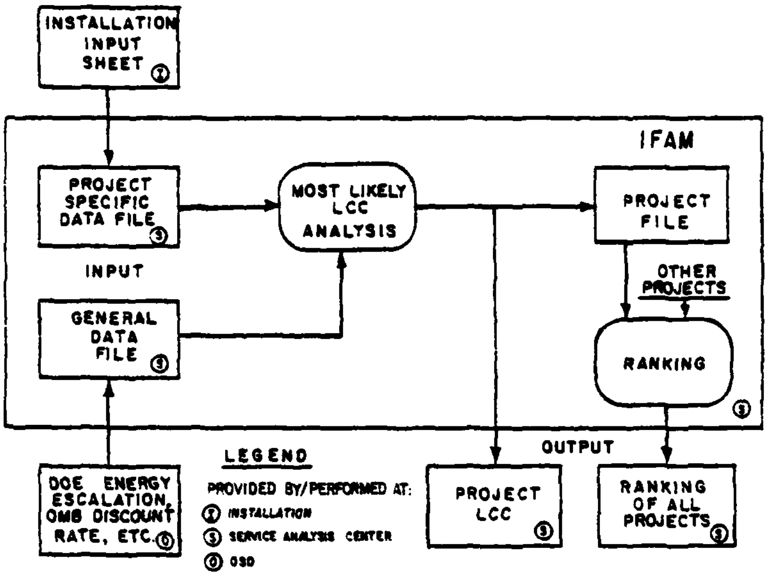
[1] "Economic Analysis and Program Evaluation for Resource Management," DoDI 7041.3, October 18, 1972.

[2] IFAM was programmed using the VisiCalc (VisiCorp) electronic ledger sheet. Other commercial electronic ledger sheet programs such as SuperCalc (Sorcim) or MultiPlan (MicroSoft) can be used.

FIGURE 2-1 SYSTEM FLOW CHART



The project-specific data are combined with the general data directly on an electronic ledger "spread sheet" on the computer monitor screen. The spread sheet is the only display needed for the LCC analysis; IFAM software contains all the analysis algorithms which are "behind" the spread sheet. A hard copy example of a project LCC analysis spread sheet, as performed by IFAM, is at Appendix B.

IFAM calculates the most likely project LCC and several other project energy and financial indices, such as savings-to-investment ratio (SIR), energy (MBtus) saved, etc. It also calculates a statistical measure of the likelihood of the various output indices being achieved and screens and ranks all projects considered according to desired indices.[3]

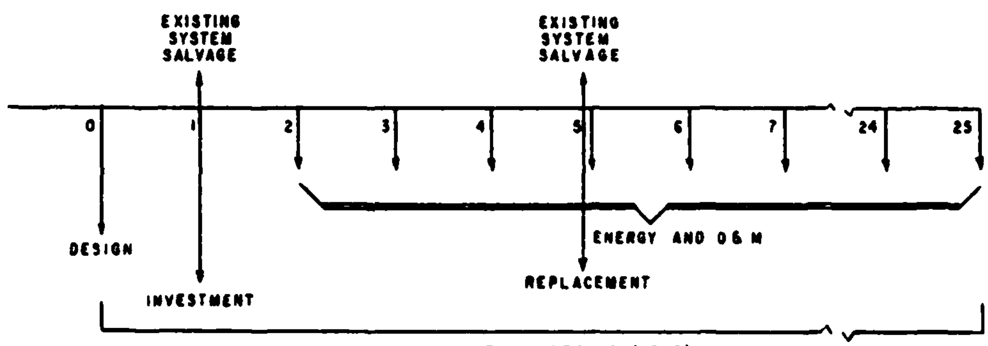
[3]The computer program listing is available from the Deputy Assistant Secretary of Defense (Installations) in hard copy or diskette.

PREPARATION FOR ANALYSIS

For each proposed project, installation personnel must complete an input form (Appendix A), using data from the standard planning and estimating process used for any construction project. In addition to discrete estimates of LCC element values and schedule milestone dates, installation engineering personnel also should provide high and low values and early and late dates to establish a practical range around each cost and schedule estimate. IFAM will employ these ranges in the statistical analysis of economic uncertainty.

Visualizing each proposed project's life by a time line similar to Figure 2-2 should assist installation personnel in estimating the timing of project cash flow, which is required on the input sheet.

FIGURE 2-2 LCC CASH FLOW TIMELINE



The FEMP analysis method of NBS Handbook 135 makes several assumptions about the timing of the date of study (DOS), design, investment, and annual costs to simplify a complex analysis (e.g. mixing mid-calendar year energy projections with fiscal year cash flows). The assumptions can generate inaccuracies in certain output ranking variables, but are the only reasonable method for use in manual computations. IFAM data processing algorithms, using

the actual DOS and projections of construction start date and beneficial occupancy date (BOD) can easily accommodate the cash flow timing, thus provide a better estimate of a project's LCC, precluding the need for simplifying assumptions. Figures 2-3 and 2-4 illustrate the difference between the IFAM analysis using the actual MILCON planning cycle and an analysis using the NBS Handbook 135 assumptions.

When the installation input form is complete, it is sent to an analysis center for processing.

PROPOSED ANALYSIS PROCESS

The basis for the system is an electronic ledger sheet, or "spread sheet," which incorporates all general and project-specific data in a single presentation. The ledger sheet is visible to the analyst on the cathode ray tube monitor of the microcomputer. The analyst has only to enter values for project-specific data by the microcomputer keyboard in the appropriate cells of the ledger sheet. Using those data and appropriate items of data from the general data file (previously built), IFAM produces a best estimate of the project's LCC.

When the analysis of all competing projects has been completed, IFAM can provide a ranking of projects according to the desired parameter(s). If any data are changed, either project-specific or general, entry of the new data will automatically and essentially instantaneously change the output LCC information of affected projects and the concomitant ranking of all projects. This capability not only accommodates actual changes in cost estimates, but also allows the testing of the sensitivity of projects' LCCs and LCC rankings to changes in the value of input financial parameters.

FIGURE 2-3 MILCON CYCLE

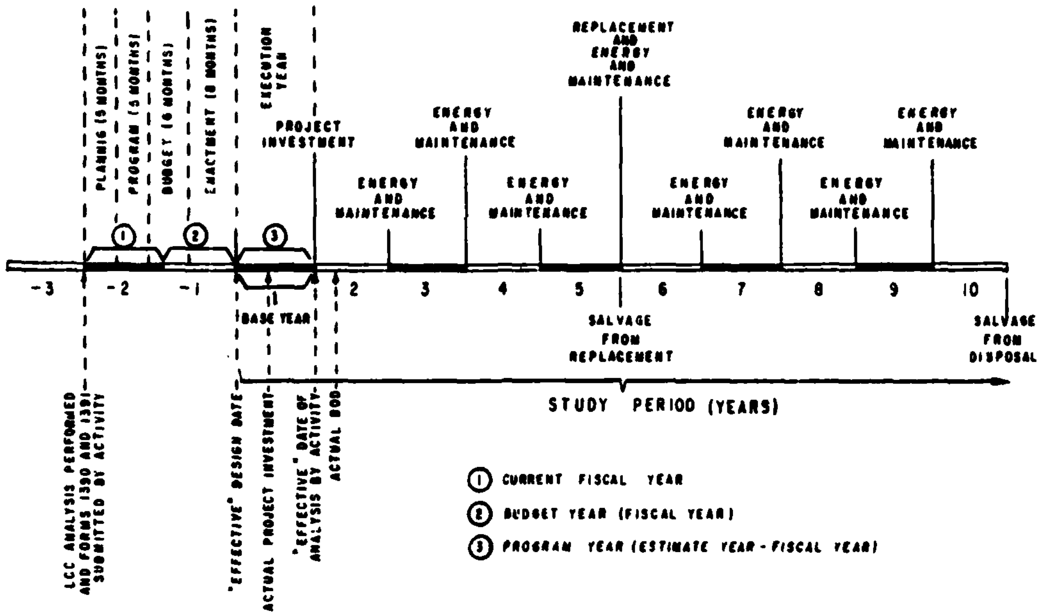
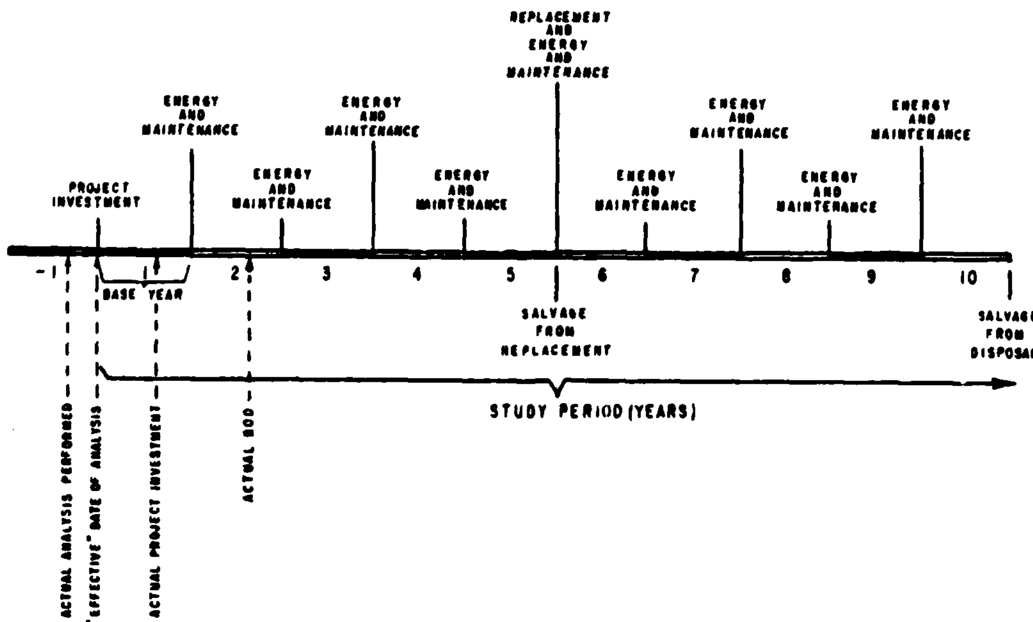


FIGURE 2-4 FEMP CYCLE

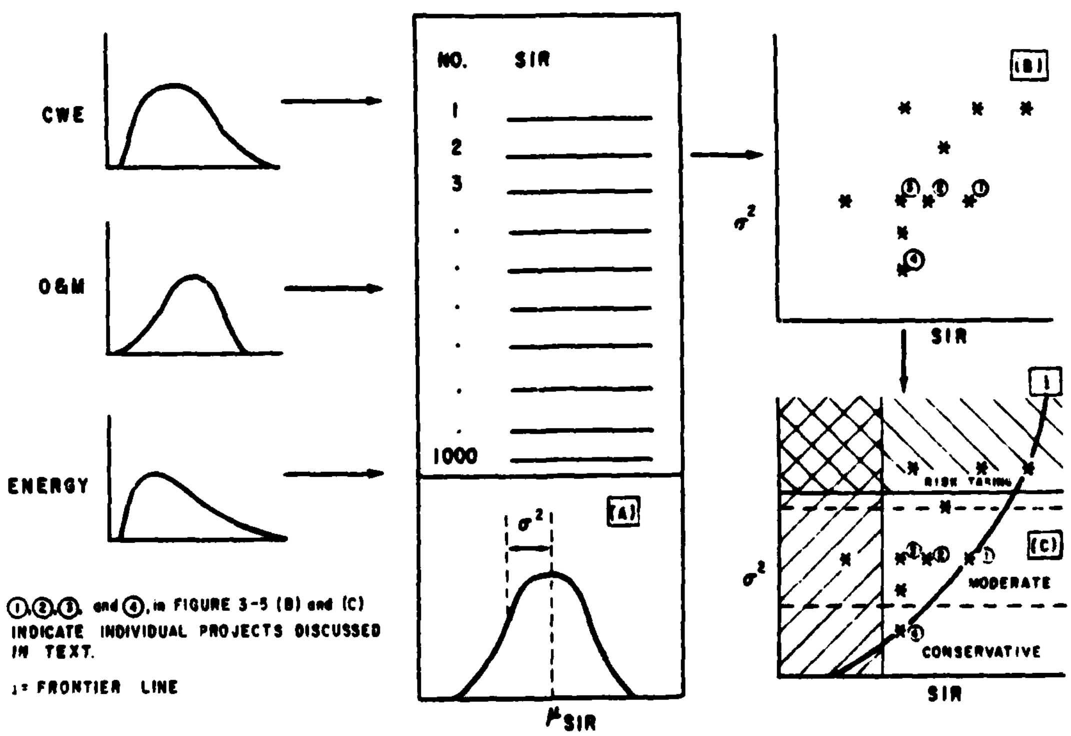


Sensitivity analysis is a method of measuring the responsiveness of a project's financial parameters--LCC, SIR, energy savings (MBtus or dollars) to cost ratio (E/C) etc.--to a range of values for a selected or uncertain key input. Frequently called "what if" analysis, it allows the analyst to assess the effect of a change in an input parameter on the project's LCC. For instance, a change in the discount rate (established at 7 percent by OMB Circular A-94), may be under consideration. Or the planned opening or closing of a refinery or pipeline may change the projected fuel cost for installations in a certain area. Or an uncertain economic outlook in an area may bring about a wide range in the project's construction working estimate (CWE). The analyst's substitution of the proposed values for the values used in the original analysis on the ledger sheet will trigger IFAM to recalculate and display the entire ledger sheet with the new results. A change in the value of one project-specific input may cause a change in the ranking of that project's LCC relative to that of other projects. A change in the value of a general input may change the value, hence the ranking, of all projects' LCCs. IFAM generates new rankings for each change in input data.

The analysis algorithms of IFAM combine a standard "present value" financial analysis with a statistical analysis of the economic uncertainty of a project. The GNP deflator and appropriate differential escalation and discount rates are applied to each cash flow item of the project time line to determine the present value of the financial parameters -- LCC, SIR, E/C, etc. -- associated with the future cash flow of the project. The economic uncertainty or risk analysis uses the ranges of schedule and dollar value estimates to produce the most probable value of LCC and a measure of the likelihood of achieving that value.

IFAM performs risk analysis by incorporating a statistical approximation of Monte Carlo simulation techniques combined with elements of portfolio management theory. The basic tenet in this method is that a decision maker, given the choice between two ECIP projects of equal SIR (or E/C, or other ranking index), would prefer the project with the higher certainty of achieving the computed SIR value. Another way of saying this is that the project with the lowest percentage variance would be preferred.[4,5] Conversely, if two projects have the same percentage variance of the SIR, the project with the higher computed SIR would be preferred. Figure 2-5 illustrates IFAM's risk analysis technique.

FIGURE 2-5 STATISTICAL UNCERTAINTY ANALYSIS



[4] Hertz, D. B., "Risk Analysis in Capital Investment," Harvard Business Review, January - February, 1964.

[5] Hertz, D. B., "Investment Policies That Pay Off," Harvard Business Review, January - February, 1968.

The algorithm combines probability distributions of the inputs and calculates the most likely mean and variance of the outputs. In effect, for each project the computer approximates the performance of a Monte Carlo simulation using randomly selected values of each cost element from its unique distribution curve of probable values. In a Monte Carlo simulation, as shown in Figure 2-5(A), after 1,000 or more iterations of calculating discrete values of the SIR, the mean and variance of the resulting distribution curve is calculated for that ECIP project. The SIR mean is then plotted against its percentage variance. The next ECIP project is then simulated using its set of cost element distribution curves, and a mean and percentage variance are computed and plotted as before. After values for all ECIP projects have been plotted, Figure 2-5(B) is obtained.

Using the two criteria for preferred investments, i.e., high SIR and low variance, projects to the right and downward on the normalized percentage variance versus SIR graph in Figure 2-5(B) are preferred. For example, project 1 in Figure 2-5(B) is preferred to projects 2 or 3 because it has a higher SIR at the same variance. Likewise project 4 is preferred to project 3 because at the same SIR value it has lower variance or a better probability of being achieved. Consequently, projects to the right and downward are preferred. A "frontier" line (i) may be drawn of the most favorable projects.

Finally, Figure 2-5(C) can be divided into three distinct management decision-making policy regions: conservative, moderate, and risk-taking. For example, a risk-taking management policy would invest in a project that had the highest possible return (e.g., highest SIR) and accept a larger risk of actually achieving that value. Conversely, a conservative policy would invest in a project with lower but more certain return (e.g., lower SIR value).

Also, screening criteria may be imposed: SIR must be greater than 1.0 or variance must be less than 30 percent (as shown in Figure 2-5(C) by the vertical and horizontal lines). The "acceptable area" (unshaded) now includes those projects meeting the screening and investment policy tests.

More than one index (SIR, LCC, and E/C, for example) may be simulated, plotted, and screened. The final acceptable area of projects will be composed of those projects contained in the feasible acceptable areas of all screens.

The mean value of the index is a more probable estimate than the discrete value computed without statistical analysis. Examples from the literature suggest that discrete rates of return on investment of 20 percent would actually be about 7 percent after uncertainty analysis. This reflects the higher probability of achieving the 7 percent based on the uncertainty of the inputs. Projects ranked by this "more probable" index will have a more accurate ranking since rank is based on higher probabilities of achievement.

A final question concerns the possibility of unrealistic estimates provided by the installation for the low and high values of the cost elements. By providing narrow boundaries for each input estimate it is possible to artificially increase the weighted mean SIR and lower the variance. If this becomes a problem, it may be mitigated by providing guidelines for setting the low and high values, or providing for default values or upper and lower limits in the IFAM software. For example, if historical construction bidding cost data for similar projects is available by construction region, the 90 percent confidence interval around the mean low bid may be determined and applied to the installation's construction estimate. The range for other large cost drivers and savings values may be determined in the same way. The estimated energy costs may similarly be bracketed using low, expected, and high values

for the ranges of differential escalation rates provided by DOE or by alternate forecasts such as those provided to subscribers by private econometric services (e.g., Data Resources, Inc., Chase Econometrics).

3. IMPLEMENTATION OF THE PROPOSED METHOD

The stage is well set for implementing IFAM. First, it takes advantage of new microcomputer hardware and software which simplify its use. The method simultaneously improves rigor and accuracy of ECIP project evaluation and eliminates the redundant manual calculations now needed for even limited analysis. Second, potential users in appropriate organizations of each of the Military Departments have contributed to and are familiar with IFAM.[1]

We recommend the first step of IFAM implementation in the DoD be conducted as a trial -- a pilot program.

The Deputy Assistant Secretary of Defense (Installations) (DASD(I)) should enlist the cooperation of the three Military Departments. One major command each in the Army and Air Force and one facilities engineering division headquarters in the Navy should be selected to use IFAM to analyze and rank all proposed ECIP projects within its purview during the next available fiscal cycle. Upon completion of the ECIP package submission for inclusion in the MILCON appropriations, the DASD(I) should review comments and recommendations from the Military Departments concerning the utility of IFAM and encourage the DoD-wide implementation -- or retirement -- of IFAM accordingly.

If IFAM proves beneficial for ECIP, it should have similar advantage in the DoD major construction program and in such other energy- and construction-related programs as:

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[1]ECIP-knowledgeable representatives of the Corps of Engineers, the Naval Facilities Engineering Command and the Air Force Engineering and Services Center have been consulted on ECIP during the development of IFAM, and have received an IFAM demonstration.

TABLE 3-1. DoD PROGRAMS IN WHICH IFAM COULD BE USED BENEFICIALLY

ALL MILITARY SERVICES

Alternative Energy Sources Programs (geothermal, solar, and wind)
Refuse-Derived Fuel and Biomass Programs
Facilities Metering Program
Dual Fuel and Coal Conversion Programs
Energy Conservation and Management Program (ECAM)
Maintenance Programs (O&M)
New Building Design and Construction Program (MILCON)

ARMY

Energy Engineering Analysis Program (EEAP)
Quick Return on Investment Program (QRIP)
Family Housing Energy Conservation

NAVY & MARINE CORPS

Energy Engineering Program (EEP)
Boiler Tune-Up Program
Family Housing Conservation Programs
Energy Conservation Opportunity Program (ECOP)
Federal Agencies Substitution Task Program (FAST)
Reserve Facilities Energy Conservation Program
Navy Exchange and Commissary Conservation Program

AIR FORCE

Energy Audits and Technical Surveys Program
O&M/Management Actions Program
Colloidal Boiler Fuels Program
Fluidized-Bed Combustion and Coal Gasification Programs
M-X Renewable Energy Systems Program
Power Systems and Resource Conservation R&D Programs
Terrestrial Energy R&D Programs
Process Energy Use Analysis Program
Process Equipment Retrofits Program

APPENDIX A

INSTALLATION INPUT FORM

INSTALLATION INPUT FORM

Project Name: ____________________

Facility: ____________________

Agency: ____________________

Major Claimant: ____________________

Active: Yes/No ____________________

Funding Command: ____________________

Appropriation: ____________________

DOE Region: ____________________

Utility Rate: ____________________

Residential = 1　Industrial = 3

Commercial = 2　Transportation = 4

Address: ____________________

Agency Contact: ____________________

UIC: ________　Serial No.: ________

Revised: ________　Project No.: ________

Date of Construction (Month, Year):

Low: ________

Expect: ________

High: ________

Beneficial Occupancy Date (Month, Year):

Low: ________

Expect: ________

High: ________

System Efficiency:

Existing: ________　Retrofit: ________

INSTALLATION INPUT FORM
(Continued)

(All Costs in Constant __(Yr.) Dollars)

LCC ELEMENTS	Year Occurs or Year Begins	Low Value	Most-Likely Value	High Value
Existing System				
Design	____	____	____	____
CWE	____	____	____	____
Salvage (Existing System)	____	____	____	____
Replacment	____	____	____	____
Recurring O&M	____	____	____	____
Non-Recurring O&M	____	____	____	____
Other (I__, E__, R__, M__)	____	____	____	____
Retrofit or New System				
Design	____	____	____	____
CWE	____	____	____	____
Salvage (Existing System)	____	____	____	____
Salvage (Terminal Value of New System)	____	____	____	____
Replacement	____	____	____	____
Recurring O&M	____	____	____	____
Non-Recurring O&M	____	____	____	____
Other (I__, E__, R__, M__)	____	____	____	____

INSTALLATION INPUT FORM
(Continued)

Energy Source	Annual End-Use Consumption: Existing (MBtus)	Annual End-Use Consumption: Retrofit (MBtus)	Local Cost Per MBtu (Constant Year Yr. Dollars)

For Source, Specify:

Electricity, Distillate Heating Oil (No.2), Residual Fuel Oil (No. 6), Natural Gas, M-Gas (MFBI), BPG (Propane, etc.), Bituminous Coal, or Other.

If other, state source and energy conversion factor.

APPENDIX B

SAMPLE PROJECT LCC ANALYSIS SPREAD SHEET

Project Name FACILITIES ENERGY IMPROVEMENTS Select Exist/Retrofit System Conversion %Rates= 50 50 FEMP/BNL CC
Facility NAS MOFFETT FIELD CA Address MOFFETT FIELD CA END-USE/%CC
Agency NAVFAC-WESTDIV Agency Contact D R. RYAN A/V 859- 3412
Major Claimant PACFLT UIC N00296 Serial No E3264 130690
Date Prepared 3/22/ 1979 Revised 8/5/ 1981) Project No P180 149690
Active? YES Date of Construction Beneficial Occupancy Date 1016
Funding Command? NAVFAC 1016
Appropriation? MILCON Low MAR 1982) Low APR 1983) 95500
DOE Region? ------------------------) 0 Expect JUN 1982) Expect JUN 1983) 22500
Utility Rate is? Residential=1 -----) 3 High JUL 1982) High SEP 1983) 125071
Commercial=2 3412
Industrial=3 Transportation=4 Discount Rate is? 7% (87)

Most Probable LCC Cost Elements EXISTING System Constant 1982 Dollars

FY	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
DESIGN	0	0	0	0	0	0	0	0	0	0	0	0
CWE	0	0	0	0	0	0	0	0	0	0	0	0
SALVAGE(Existing)	0	0	0	0	0	0	0	0	0	0	0	0
SALVAGE(New)	0	0	0	0	0	0	0	0	0	0	0	0
REPLACEMENT	0	0	0	0	0	0	0	0	0	0	0	0
RECURRING O&M	0	0	0	0	0	0	0	0	0	0	0	0
NON-RECURRING O&M	0	0	0	0	0	0	0	0	0	0	0	0
OTHER COST-Invest	0	0	0	0	0	0	0	0	0	0	0	0
-Energy	0	0	0	0	0	0	0	0	0	0	0	0
-Replace	0	0	0	0	0	0	0	0	0	0	0	0
-Maint	0	0	0	0	0	0	0	0	0	0	0	0

Most Probable LCC Cost Elements RETROFIT System Constant 1982 Dollars

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
DESIGN	26000	0	0	0	0	0	0	0	0	0	0	0
CWE	532250	0	0	0	0	0	0	0	0	0	0	0
SALVAGE(Existing)	0	0	0	0	0	0	0	0	0	0	0	0
SALVAGE(New)	0	0	0	0	0	0	0	0	0	0	0	0
REPLACEMENT	0	0	0	0	0	0	0	0	0	0	0	0
RECURRING O&M	0	0	0	0	0	0	0	0	0	0	0	0
NON-RECURRING O&M	0	0	0	0	0	0	0	0	0	0	0	0
OTHER COST-Invest	0	0	0	0	0	0	0	0	0	0	0	0
-Energy	0	0	0	0	0	0	0	0	0	0	0	0
-Replace	0	0	0	0	0	0	0	0	0	0	0	0
-Maint	0	0	0	0	0	0	0	0	0	0	0	0
Discount Rate (X%)=	7	1.07	.93457944									
Discount Factor	.93457944	.87343873	.81629788	.76289521	.71298618	.66634222	.62274974	.58200910	.54393374	.50834929	.47509280	.44401196
GNP Deflator	2.123	2.3353	2.5477	2.76	2.982	3.204	3.426	3.648	3.87	4.138	4.406	4.674

DOE REGION NO. 0 *** ANNUAL ENERGY DIFFERENTIAL ESCALATION RATES*** Estimate is Most Probable Mean V

		1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	
Resid.	Electricity	1.0528	1.1083881	1.1649115	1.2285252	1.2310737	1.2340292	1.2373918	1.2403616	1.2433385	1.2409574	1.2385809	1.2362090	1
	Distillate	1.025235	1.0511091	1.0776386	1.1048481	1.1328957	1.1614697	1.1911804	1.2214471	1.2524891	1.3300337	1.4125145	1.5002538	1
	LPG	1.01764	1.0357245	1.0542648	1.0732723	1.0914442	1.1100431	1.1290791	1.1485625	1.1685037	1.2206139	1.2758587	1.3344018	1
	Natural Gas	1.087195	1.1819991	1.2850768	1.3971588	1.4145795	1.4322268	1.4500930	1.4681832	1.4864995	1.5215118	1.5573473	1.5940279	1
Comm.	Electricity	1.03696	1.0758715	1.1168375	1.1599665	1.1607405	1.1615152	1.1622905	1.1630666	1.1638433	1.1618565	1.1598742	1.1578965	1
	Distillate	1.01757	1.0355818	1.0540441	1.0729706	1.0937635	1.1151157	1.1370424	1.1595588	1.1826809	1.2392490	1.2994553	1.3638331	1
	Residual	1.06293	1.1315174	1.2062708	1.2877446	1.3138218	1.3405859	1.3680574	1.3962541	1.4251952	1.4681776	1.5128028	1.5591311	1
	Natural Gas	1.06195	1.1293826	1.2027829	1.2826792	1.2970243	1.3115829	1.3263520	1.3413368	1.3565403	1.3837998	1.4117618	1.4404445	1
	Steam Coal	1.04277	1.0881532	1.1363894	1.1874879	1.2031150	1.2191082	1.2353682	1.2519243	1.2687733	1.2744891	1.2802386	1.2860220	1
Indust.	Electricity	1.05252	1.1077985	1.1659805	1.2272184	1.2343364	1.2414956	1.2486964	1.2559389	1.2632234	1.2616886	1.2601556	1.2586245	1
	Distillate	1.01757	1.0355818	1.0540441	1.0729706	1.0935316	1.1146396	1.1363090	1.1585548	1.1813923	1.2379777	1.2981959	1.3622881	1
	Residual	1.090725	1.1897268	1.2977628	1.4156424	1.4509335	1.4870938	1.5241456	1.5621724	1.6011380	1.6258576	1.6509651	1.6764664	1
	Natural Gas	1.08726	1.1821471	1.2853289	1.3975318	1.4072601	1.4170568	1.4249218	1.4368545	1.4468574	1.4870494	1.5283590	1.5708171	1
	N-Gas MFBI	1.088195	1.1841941	1.2886980	1.4024378	1.3434128	1.2868757	1.2327228	1.1808529	1.1311694	1.1612874	1.1922081	1.2239538	1
	Steam Coal	1.13725	1.2933402	1.4708571	1.6727425	1.7146856	1.7575167	1.8015018	1.8465000	1.8928027	1.9109468	1.9292649	1.9477586	1
Transp.	Gasoline	1.052645	1.1080692	1.1664196	1.2278512	1.2452264	1.2628488	1.2807220	1.2988495	1.3172350	1.3848719	1.4560502	1.5309509	1

EXISTING SYSTEM	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
U Electricity (kWh)	0	0	0	0	0	0	0	0	0	0	0	0
N Distillate (No.2)	0	0	0	0	0	0	0	0	0	0	0	0
D Residual (No.6)	0	468892.98	510599.35	556986.78	570864.08	585091.17	599676.96	614630.58	629961.43	639687.25	649565.69	659599.18
I Natural Gas	0	0	0	0	0	0	0	0	0	0	0	0
S N-Gas MFBI	0	0	0	0	0	0	0	0	0	0	0	0
C LPG,Propane,etc.	0	0	0	0	0	0	0	0	0	0	0	0
Bituminous Coal	0	0	0	0	0	0	0	0	0	0	0	0
Gasoline	0	0	0	0	0	0	0	0	0	0	0	0
Electricity (kW)	0	0	0	0	0	0	0	0	0	0	0	0
ENERGY TOTAL	0	468892.98	510599.35	556986.78	570864.08	585091.17	599676.96	614630.58	629961.43	639687.25	649565.69	659599.18
D Energy Costs	0	408850.34	416881.16	424922.55	407818.20	389870.95	373448.67	357720.60	342657.28	325184.56	308603.98	292849.93
I Investment Costs	0	0	0	0	0	0	0	0	0	0	0	0
S Non-Fuel Costs	0	0	0	0	0	0	0	0	0	0	0	0
C Replacement Costs	0	0	0	0	0	0	0	0	0	0	0	0
. Net Ann. Cash Flow	0	-408850.5	-416881.2	-424922.5	-407818.2	-389871.0	-373448.7	-357720.6	-342657.3	-325184.6	-308604.0	-292849.9
RETROFIT SYSTEM												
U Electricity (kWh)	0	0	0	0	0	0	0	0	0	0	0	0
N Distillate (No.2)	0	0	0	0	0	0	0	0	0	0	0	0
D Residual (No.6)	0	377129.38	411375.36	440748.61	459929.17	471391.33	483142.89	495190.61	507542.24	515378.04	523336.04	531420.35
I Natural Gas	0	0	0	0	0	0	0	0	0	0	0	0
S N-Gas MFBI	0	0	0	0	0	0	0	0	0	0	0	0
C LPG,Propane,etc.	0	0	0	0	0	0	0	0	0	0	0	0
Bituminous Coal	0	0	0	0	0	0	0	0	0	0	0	0
Gasoline	0	0	0	0	0	0	0	0	0	0	0	0
Electricity (kW)	0	0	0	0	0	0	0	0	0	0	0	0
ENERGY TOTAL	0	377129.38	411375.36	440748.61	459929.17	471391.33	483142.89	495190.61	507542.24	515378.04	523336.04	531420.35
D Energy Costs	0	329399.40	335805.00	342340.17	327923.14	314180.08	300877.11	288205.44	276069.35	261992.07	248633.56	235937.08
I Investment Costs	521728.97	0	0	0	0	0	0	0	0	0	0	0
S Non-Fuel Costs	0	0	0	0	0	0	0	0	0	0	0	0
C Replacement Costs	0	0	0	0	0	0	0	0	0	0	0	0
. Net Ann. Cash Flow	-521729 0	-329399.4	-335805.0	-342340.3	-327923.1	-314180.1	-300877.1	-288205.4	-276069.3	-261992.1	-248633.6	-235932.1

TEMP/BNL CONVERSIO END-USE/%CONV	RATE	N FACTORS /AT SOURCE/METER	ANNUAL END-USE ENERGY CONSUMPTION (10E6 BTU's)	Existing	Retrofit	PHYSICAL UNIT COST(1981$) Resid	Comm	Indust	NET MBTU (Source)	1982 Dollars EXISTING	RETROFIT
3412	100	3412 BTU/kWh	Electricity	0	0	0	0	0	0	0	0
138690	50	277380 BTU/Gal	Distillate (No.2)	0	0	0	0	0	0	0	0
149690	50	299380 BTU/Gal	Residual (No 6)	62060	50000	0	0	949	24120	393446.06	316988.44
1016	54	1881.4815 BTU/cf	Natural Gas	0	0	0	0	0	0	0	0
1016	54	1881.4815 BTU/cf	N-Gas MFBI	0	0	0	0	0	0	0	0
95500	54	176851.85 BTU/cf	LPG,Propane,etc.	0	0	0	0	0	0	0	0
22500	70	32142.857 kBTU/Ton	Bituminous Coal	0	0	0	0	0	0	0	0
125071	24	521129.17 BTU/Gal	Gasoline	0	0	0	0	0	0	0	0
3412	100	3412 BTU/kWh	Electricity (kW)	0	0	0	0	0		0	0
			Total 10E6 MBTU's	62060	50000				24120	393446.06	316988.44

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	VARIANCE
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
															VARIANCE
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	237793694
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	532250	0	0	0	0	0	18180959
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	44401196	41496445	.38781724	.36244602	.33873460	.31657439	.29584392	.27650833	.25841908	.24151309	.22571317	.21094688	19714662	.18424918	
6	4.674	4.942	5.21	5.478	5.746	6.014	6.282	6.55	6.818	7.086	7.354	7.622	7.89	8.158	

obable Mean Value

2	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	PARTIAL VARIANCE
9	1.2362090	1.2338416	1.2314787	1.2291204	1.2267665	1.2244172	1.2220724	1.2197321	1.2173963	1.2150649	1.2127380	1.2104156	1.2080976	1.2057841	5.9622E-4
35	1.5002538	1.5935957	1.6929073	1.7985805	1.9110334	2.0307123	2.1580936	2.2936860	2.4380323	2.5917126	2.7553458	2.9295934	3.1151615	3.3128045	1.3883238
7	1.3344018	1.3964659	1.4622538	1.5319891	1.6059884	1.6842629	1.7673187	1.8553578	1.9486793	2.0476000	2.1524541	2.2636034	2.3814196	2.5063048	0
73	1.5940279	1.6315727	1.6700020	1.7093367	1.7495982	1.7908083	1.8329893	1.8761641	1.9203561	1.9655893	2.0118883	2.0592781	2.1077845	2.1574338	6.6894E-4
2	1.1578965	1.1559234	1.1539547	1.1519906	1.1500311	1.1480760	1.1461254	1.1441793	1.1422377	1.1403006	1.1383679	1.1364396	1.1345158	1.1325964	0
53	1.3638331	1.4321312	1.5048140	1.5821631	1.6644780	1.7520774	1.8453008	1.9445891	2.0500866	2.1624422	2.2820118	2.4092561	2.5446703	2.6887781	0
10	1.5591311	1.6072299	1.6571661	1.7090098	1.7628340	1.8187142	1.8767291	1.9369602	1.9994920	2.0644126	2.1318132	2.2017885	2.2744368	2.3498603	0
10	1.4404445	1.4698479	1.5000505	1.5310118	1.5627720	1.5953515	1.6287715	1.6630538	1.6982206	1.7342947	1.7712995	1.8092591	1.8481979	1.8881414	0
16	1.2860220	1.2918395	1.2976914	1.3035777	1.3094988	1.3154549	1.3214461	1.3274726	1.3335347	1.3396325	1.3457664	1.3519364	1.3581428	1.3643859	0
54	1.2586245	1.2570953	1.2555679	1.2540424	1.2525187	1.2509969	1.2494769	1.2479588	1.2464425	1.2449281	1.2434155	1.2419047	1.2403958	1.2388887	3.4596E-4
59	1.3622801	1.4304785	1.5030552	1.5802913	1.6624860	1.7499576	1.8430449	1.9421084	2.0475317	2.1597233	2.2791175	2.4061769	2.5413934	2.6852909	0
51	1.6764666	1.7023486	1.7286773	1.7553993	1.7825412	1.8101096	1.8381115	1.8665536	1.8954432	1.9247872	1.9545931	1.9848681	2.0156198	2.0468559	.57977465
90	1.5708171	1.6144559	1.6593080	1.7054074	1.7527887	1.8014875	1.8515406	1.9029857	1.9558614	2.0102077	2.0660655	2.1234767	2.1824847	2.2431340	.03099494
81	1.2239538	1.2565441	1.2900039	1.3243557	1.3596232	1.3958309	1.4330039	1.4711679	1.5103494	1.5505755	1.5918741	1.6342738	1.6778041	1.7224950	.08797707
79	1.9477586	1.9664297	1.9852797	2.0043105	2.0235238	2.0429213	2.0625047	2.0822759	2.1022367	2.1223889	2.1427343	2.1632748	2.1840122	2.2049484	.01369681
02	1.5309589	1.6097973	1.6927752	1.7801144	1.8720481	1.9688229	2.0706982	2.1779482	2.2908616	2.4097432	2.5349143	2.6667139	2.8054997	2.9516498	.74683943

92	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	PARTIAL VARIANCE
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
69	659599.18	669790.21	680141.27	690654.94	701333.08	712180.50	723197.72	734388.17	745754.64	757299.94	769026.93	780938.52	793037.66	805327.36	8.9749E10
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	PRESENT VA
.69	659599.18	669790.21	680141.27	690654.94	701333.08	712180.50	723197.71	734388.17	745754.64	757299.94	769026.93	780938.52	793037.66	805327.36	
.90	292869.93	277939.13	263770.51	250325.13	237566.02	225458.11	213968.11	203864.45	192717.17	182897.85	173579.50	164736.55	156344.69	148380.90	Energy
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Invest
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Nonfuel
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Replace
4.0	-292869.9	-277939.1	-263770.5	-250325.1	-237566.0	-225458.1	-213968.1	-203864.4	-192717.2	-182897.8	-173579.5	-164736.5	-156344.7	-148380.9	
															PARTIAL VAR
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
.84	531420.55	539631.17	547970.73	556441.30	565044.96	573783.84	582668.10	591675.93	600833.58	610135.31	619583.41	629180.25	638928.19	648829.65	5.8237E10
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	PRESENT VI
.84	531420.55	539631.17	547970.73	556441.30	565044.96	573783.84	582668.10	591675.93	600833.58	610135.31	619583.41	629180.25	638928.19	648829.65	
.56	235957.08	223927.75	212512.50	201679.92	191400.20	181645.37	172380.10	163683.33	155266.02	147355.66	139848.13	132723.61	125962.53	119546.33	Energy
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Invest
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Nonfuel
									137503.51	0	0	0	0	0	Replace

2

PHYSICAL	UNIT COST(1981$)		NET MBTU	1982 Dollars	
Resid	Comm	Indust	(Source)	EXISTING	RETROFIT
0	0	0	0	0	0
0	0	0	0	0	0
0	0	949	24120	393446 86	316988.44
0	0	0	0	0	0
0	0	0	0	0	0
0	0	0	0	0	0
0	0	0	0	0	0
0	0	0	0	0	0
0	0	0		0	0
			24120	393446 86	316988 44

	2001	2002	2003	2004	2005	2006	VARIANCE
	0	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0	0	0	0	0	0	0
							VARIANCE
	0	0	0	0	0	0	0
	0	0	0	0	0	0	237793494
	0	0	0	0	0	0	0
	0	0	0	0	0	0	0
	532250	0	0	0	0	0	18180959
	0	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0	0	0	0	0	0	0
3	.25841900	.24151309	.22571317	.21094600	.19714662	.18424918	
5	6.818	7.086	7.354	7.622	7.89	8.158	

	2001	2002	2003	2004	2005	2006	PARTIAL VARIANCE
11	1.2173763	1.2150449	1.2127380	1.2104156	1.2080976	1.2057841	5.9622E-4
0	2.4380323	2.5917126	2.7553458	2.9295934	3.1151615	3.3128045	1.3883238
8	1 9486793	2.0476000	2 1524561	2.2636034	2.3814196	2.5063040	0
11	1.9203561	1.9655893	2.0118883	2.0592781	2.1077845	2.1574338	6.6894E-4
3	1.1422377	1.1403006	1.1383679	1.1364396	1.1345158	1.1325964	0
1	2.0500866	2.1624422	2.2820110	2.4092561	2.5446703	2.6887781	0
2	1.9994920	2.0644126	2.1318132	2.2017885	2.2744368	2.3498603	0
8	1.6982286	1.7342947	1.7712995	1.8092591	1.8481979	1.8881414	0
6	1.3335347	1.3396325	1.3457664	1.3519364	1.3581428	1.3643859	0
8	1.2464425	1.2449281	1.2434155	1.2419047	1.2403958	1.2388887	3.4596E-4
0	2.0475317	2.1597233	2.2791175	2.4061769	2.5413934	2.6852909	0
6	1 8954432	1.9247872	1.9545931	1.9848681	2.0156198	2.0468559	.57977465
7	1.9558614	2.0102077	2.0660655	2.1234767	2.1824847	2.2431340	.03099496
9	1.5103494	1.5505755	1.5918741	1.6342738	1.6778041	1.7224950	.08797707
9	2.1022367	2.1223887	2.1427343	2.1632748	2.1840122	2.2049484	.01349681
2	2.3908616	2.4097432	2.5349143	2.4667139	2.8054997	2.9516498	.74683942

	2001	2002	2003	2004	2005	2006	PARTIAL VARIANCE
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
17	745754.64	757299.94	769026.93	780938.52	793037.44	805327.36	8.9749E10
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	
17	745754 64	757299.94	769026.93	780938.52	793037.44	805327.36	
15	192717.17	182897.85	173579.50	164736.55	156344.69	148380.90	
0	0	0	0	0	0	0	
0	0	0	0	0	0	0	
0	0	0	0	0	0	0	
.4	-192717.2	-182897.8	-173579.5	-164736.5	-156344.7	-148380.9	

	PRESENT VALUE	VARIANCE
Energy	6738696.5	1.2188E13
Invest	0	0
Nonfuel	0	0
Replace	0	0

							PARTIAL VARIANCE
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
93	600833.50	610135.31	619583.41	629180.25	638928.19	648829.65	5.8257E10
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	
93	600833 50	610135.31	619583.41	629180.25	638928.19	648829.65	
32	155266.82	147255.66	139848.13	132723.61	125962.53	119546.33	
0	0	0	0	0	0	0	
0	0	0	0	0	0	0	
0	137543.51	0	0	0	0	0	
3	-292810.3	-147355.7	-139848 1	-132723.6	-125962.5	-119546.3	

	PRESENT VALUE	VARIANCE
Energy	5429178 6	7 9114E12
Invest	521726 97	3 2294E10
Nonfuel	0	0
Replace	137543.51	2 4670E9

EXIST Invest undisc. 0

IFAM
MICROCOMPUTER LCC
INPUT/OUTPUT
LEDGER SHEET

APPENDIX B

3

Discount Factor	93457944	.87343873	81629788	76289521	71298618	66634222	62274974	58200910	54393374	50834929	47509280
GNP Deflator	2.123	2.3353	2.5477	2 76	2.982	3 204	3 424	3 648	3 87	4 138	4 406

DOE REGION NO 0 *** ANNUAL ENERGY DIFFERENTIAL ESCALATION RATES*** Estimate is Most Prob

		1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Resid.	Electricity	1.0528	1.1003881	1.1649115	1.2205252	1.2314737	1.2344292	1.2373918	1.2403616	1.2433385	1.2409574	1 2385809
	Distillate	1.025235	1.0511091	1.0776386	1.1040401	1.1328957	1.1616697	1 1911804	1.2214471	1.2524091	1 3300337	1 4125145
	LPG	1.01764	1.0357245	1.0542648	1.0732723	1.0914442	1.1100431	1.1290791	1 1485625	1 1685037	1.2206139	1.2758587
	Natural Gas	1.087195	1.1819991	1.2050768	1.3971508	1.4145795	1.4322260	1 4500930	1 4681832	1 4864995	1.5215110	1 5573473
Comm.	Electricity	1.03694	1.0750715	1.1160375	1.1599665	1.1607405	1.1615152	1 1622905	1.1630666	1 1630433	1.1610565	1 1590742
	Distillate	1.01757	1.0355810	1.0540441	1.0729706	1.0937635	1.1151157	1.1370424	1.1595588	1 1826809	1.2393490	1 2996553
	Residual	1.06293	1.1315174	1.2062708	1.2877446	1.3130210	1.3405859	1.3680574	1.3962541	1 4251952	1.4681776	1 5128020
	Natural Gas	1.04195	1.1273826	1.2027029	1.2026792	1.2970263	1.3115029	1 3263520	1.3413368	1.3565403	1.3837990	1 4117610
	Steam Coal	1.04277	1.0881532	1.1363094	1.1874079	1.2031150	1.2191082	1.2353682	1.2519243	1 2687733	1.2744891	1 2802386
Indust.	Electricity	1.05252	1.1077985	1.1659805	1.2272184	1.2343364	1.2414956	1 2486964	1.2559389	1 2632234	1 2616886	1 2601556
	Distillate	1.01757	1.0355810	1 0540441	1.0729706	1.0935316	1.1146396	1 1363090	1 1585540	1 1812923	1 2279777	1.2981959
	Residual	1 090725	1.1897260	1.2977620	1.4156624	1 4509335	1.4870938	1 5241656	1.5621724	1 6011380	1.6258576	1.6509651
	Natural Gas	1.08726	1.1821471	1.2853289	1.3975318	1.4072601	1.4170564	1.4269210	1 4368545	1 4468574	1 4870494	1.5283590
	N-Gas MFBI	1.088195	1.1841941	1.2886900	1.4024370	1.3434120	1.2868757	1.2327220	1.1808529	1.1311694	1 1612874	1 1922081
	Steam Coal	1.13725	1.2933482	1.4708571	1.6727425	1.7146056	1.7575167	1.8015018	1 8465888	1 8928027	1 9109468	1.9292649
Transp.	Gasoline	1.052645	1.1080692	1.1664196	1.2278512	1.2452264	1.2628488	1 2807220	1.2988495	1.3172350	1 3848719	1 4560502

EXISTING SYSTEM	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
U Electricity (kWh)	0	0	0	0	0	0	0	0	0	0	0
N Distillate (No.2)	0	0	0	0	0	0	0	0	0	0	0
D Residual (No.6)	0	468092.98	510599.35	556984.78	570864.08	585091.17	599676.96	614630.58	629961.43	639687.25	649565.69
I Natural Gas	0	0	0	0	0	0	0	0	0	0	0
S N-Gas MFBI	0	0	0	0	0	0	0	0	0	0	0
C LPG,Propane,etc.	0	0	0	0	0	0	0	0	0	0	0
Bituminous Coal	0	0	0	0	0	0	0	0	0	0	0
Gasoline	0	0	0	0	0	0	0	0	0	0	0
Electricity (kW)	0	0	0	0	0	0	0	0	0	0	0
ENERGY TOTAL	0	468092.98	510599.35	556984.78	570864.08	585091.17	599676.96	614630 58	629961.43	639687.25	649565 69
D Energy Costs	0	408850.54	416801.16	424922.55	407018.28	389870.95	373440.67	357720.60	342657 28	325184.56	308603 98
I Investment Costs	0	0	0	0	0	0	0	0	0	0	0
S Non-Fuel Costs	0	0	0	0	0	0	0	0	0	0	0
C Replacement Costs	0	0	0	0	0	0	0	0	0	0	0
. Net Ann. Cash Flow	0	-408850.5	-416801.2	-424922.5	-407018.2	-389871.0	-373440 7	-357720.6	-342657 3	-325184.6	-308604.0
RETROFIT SYSTEM											
U Electricity (kWh)	0	0	0	0	0	0	0	0	0	0	0
N Distillate (No.2)	0	0	0	0	0	0	0	0	0	0	0
D Residual (No.6)	0	377129.38	411375.56	448748.61	459929.17	471391.53	483142.89	495190 61	507542.24	515378.06	523336 84
I Natural Gas	0	0	0	0	0	0	0	0	0	0	0
S N-Gas MFBI	0	0	0	0	0	0	0	0	0	0	0
C LPG,Propane,etc.	0	0	0	0	0	0	0	0	0	0	0
Bituminous Coal	0	0	0	0	0	0	0	0	0	0	G
Gasoline	0	0	0	0	0	0	0	0	0	0	0
Electricity (kW)	0	0	0	0	0	0	0	0	0	0	0
ENERGY TOTAL	0	377129.38	411375.56	448748.61	459929.17	471391.53	483142.89	495190.61	507542.24	515378 06	523336 84
D Energy Costs	0	329399.40	335805.00	342348.17	327923.14	314108.08	300877.11	288205.44	276069.35	261992 07	248633 56
I Investment Costs	521728.97	0	0	0	0	0	0	0	0	0	0
S Non-Fuel Costs	0	0	0	0	0	0	0	0	0	0	0
C Replacement Costs	0	0	0	0	0	0	0	0	0	0	0
Net Ann. Cash Flow	-521729 0	-329399.4	-335805.0	-342348.2	-327923.1	-314108 1	-300877.1	-288205.4	-276069.3	-261992.1	-248633 6

	EXISTING MP VALUE	VARIANCE:	RETROFIT MP VALUE	VARIANCE
TLCC	6738496.5	5.9898E13:	6088451.1	3.8915E13
NLCC	-	- :	650245.40	9.8814E13
SIR	-	- :	2.1451741	30592989.
E/C (MBTU's/CWE)/$1000	-	- :	45.317050	1.3834E11
E/C (MBTU's/PV INVEST)/$1000	-	- :	46.230980	1.8788E13

**MILCON A
1983
D+CWE-Sal 614075

	1	2	3	4	5	6	7	8	9	10	11
Exist Ann. Cash Flow	0	-468093.0	-510599.3	-556986.8	-570864.1	-585091.2	-599677.0	-614630.6	-629961.4	-639687.2	-649565.7
Retro Ann. Cash Flow	-558250.0	-377129.4	-411375.6	-448740.6	-459929.2	-471391.5	-483142.9	-495190.6	-507542.2	-515378.1	-523336.8
Total Ann. Cash Flow	-558250.0	90963.686	99223.785	108238.17	110934.91	113699.64	116534.07	119439.97	122419.19	124309.19	126228.85
	-558250	-419556.4	-244762.1	-38123.46	212817.48	483808.57	782608.42	1109035.6	1463917.6	1840612.8	2241544.9
Simple Payback is--)	0	0	0	0	4.1239950	0	0	0	0	0	0
Exist Disc Cash Flow	0	-408850.5	-416801.2	-424922.5	-407018.2	-389871.0	-373440.7	-357720.6	-342657.3	-325184.6	-308604.0
Retro Disc Cash Flow	-521729.0	-329399.4	-335805.0	-342348.2	-327923.1	-314108.1	-300877.1	-288205.4	-276069.3	-261992.1	-248633.6
Total Disc Cash Flow	-521729.0	79451.136	80996.165	82574.378	79095.061	75762.869	72571.559	69515.153	66587.927	63192.488	59970.416
	-521729.0	-442277.8	-361281.7	-278707.3	-199612.2	-123849.4	-51277.88	18237.350	84825.277	148017.76	207988.18
Disc. Payback is --)	0	0	0	0	0	0	0	7.7376493	0	0	0

4

0	0	0	0	0	0	0	0	0	0	0	0
38781724	.36244602	.33873460	31657439	29586392	27650833	25841900	24151309	22571317	21094688	19714662	18424918
5.21	5.478	5.746	6.014	6.282	6.55	6.818	7.086	7.354	7.622	7.89	8.158

1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	PARTIAL VARIANCE
1.2314787	1.2291204	1.2267665	1.2244172	1.2220724	1.2197321	1.2173963	1.2150649	1.2127380	1.2104156	1.2080976	1.2057841	5.9622E-4
1.6929073	1.7985885	1.9110334	2.0307123	2.1580936	2.2936860	2.4380323	2.5917126	2.7553458	2.9295934	3.1151615	3.3128845	1.3883238
1.4622538	1.5319891	1.6059084	1.6842629	1.7673187	1.8553578	1.9486793	2.0476000	2.1524561	2.2636034	2.3814196	2.5063048	0
1.6708028	1.7093367	1.7495982	1.7988083	1.8329892	1.8761641	1.9203561	1.9655893	2.0118883	2.0592781	2.1077845	2.1574338	6.6894E-4
1.1539547	1.1519986	1.1500311	1.1480760	1.1461258	1.1441793	1.1422377	1.1403006	1.1383679	1.1364396	1.1345158	1.1325964	0
1.5048140	1.5821631	1.6644788	1.7520774	1.8453088	1.9445891	2.0500866	2.1624422	2.2820118	2.4092561	2.5446703	2.6887781	0
1.6571461	1.7098098	1.7628348	1.8187142	1.8767391	1.9349682	1.9994928	2.0644126	2.1318132	2.2017885	2.2744368	2.3498683	0
1.5080505	1.5318118	1.5627728	1.5953515	1.6287715	1.6630538	1.6982286	1.7342947	1.7712995	1.8092591	1.8481979	1.8881414	0
1.2974914	1.3035777	1.3094988	1.3154549	1.3214461	1.3274726	1.3335347	1.3396325	1.3457664	1.3519364	1.3581428	1.3643859	0
1.2555679	1.2540424	1.2525187	1.2509969	1.2494769	1.2479588	1.2464425	1.2449281	1.2434155	1.2419047	1.2403958	1.2388887	3.4596E-4
1.5030552	1.5802913	1.6624860	1.7499576	1.8430449	1.9421884	2.0475317	2.1597233	2.2791175	2.4061769	2.5413934	2.6852989	0
1.7286773	1.7553993	1.7825412	1.8101096	1.8381115	1.8665536	1.8954432	1.9247872	1.9545931	1.9848681	2.0156198	2.0468559	.57977463
1.6593080	1.7054874	1.7527887	1.8014875	1.8515486	1.9029857	1.9558614	2.0102877	2.0660655	2.1234767	2.1824847	2.2431340	.83099496
1.2988039	1.3243557	1.3596232	1.3958309	1.4330039	1.4711679	1.5103494	1.5505755	1.5918741	1.6342738	1.6778041	1.7224958	.88797707
1.9852797	2.0043185	2.0235238	2.0429213	2.0625047	2.0822759	2.1022367	2.1223889	2.1427343	2.1632748	2.1840122	2.2049484	.01369681
1.6927752	1.7881144	1.8720481	1.9688229	2.0786982	2.1779482	2.2988616	2.4097432	2.5349143	2.6667139	2.8054997	2.9516498	.74683943

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	PARTIAL VARIANCE
	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0
	680141.27	690454.94	701333.80	712180.50	723197.71	734388.17	745754.64	757299.94	769024.93	780938.52	793037.64	805327.36	8.9749E10
1	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	

													PRESENT VALUE		VARIANCE
11	680141.27	690454.94	701333.80	712180.50	723197.71	734388.17	745754.64	757299.94	769024.93	780938.52	793037.64	805327.36			
12	263770.51	250325.13	237566.02	225458.11	213968.11	203064.45	192717.17	182897.85	173579.50	164736.55	156344.69	148380.90	Energy	6738696.5	1.2188E13
0	0	0	0	0	0	0	0	0	0	0	0	0	Invest	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	Nonfuel	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	Replace	0	0
.1	-263770.5	-250325.1	-237566.0	-225458.1	-213968.1	-203064.4	-192717.2	-182897.8	-173579.5	-164736.5	-156344.7	-148380.9			

													PARTIAL VARIANCE
0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	547970.73	556441.30	565844.96	573783.84	582660.10	591675.93	600833.58	610135.31	619583.41	629180.25	638928.19	648829.65	5.8257E10
0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	

2

3

													PRESENT VALUE		VARIANCE
17	547970.73	556441.30	565844.96	573783.84	582660.10	591675.93	600833.58	610135.31	619583.41	629180.25	638928.19	648829.65			
75	212512.50	201679.93	191400.28	181645.27	172388.18	163603.33	155266.82	147355.66	139848.13	132723.61	125962.53	119546.33	Energy	5429178.6	7.9116E12
0	0	0	0	0	0	0	0	0	0	0	0	0	Invest	521728.97	3.2294E10
0	0	0	0	0	0	0	0	0	0	0	0	0	Nonfuel	0	0
0	0	0	0	0	0	0	137543.51	0	0	0	0	0	Replace	137543.51	2.4690E9
7.8	-212512.5	-201679.9	-191400.3	-181645.3	-172388.1	-163603.3	-292810.3	-147355.7	-139848.1	-132723.6	-125962.5	-119546.3			

tt al Amount

985	1986	1987	1988	1989	1990
30	784126.94	842502.59	900878.24	959253.89	1017629.5

EXIST Invest undisc.	0
RETRO Invest undisc.	558250
DIFF Invest undisc	558250

13	14	15	16	17	18	19	20	21	22	23	24	25
.2	-680141.3	-690454.9	-701333.8	-712180.5	-723197.7	-734388.2	-745754.4	-757299.9	-769024.9	-780938.5	-793037.7	-805327.4
.2	-547970.7	-556441.3	-565845.0	-573783.8	-582660.1	-591675.9	-1133084.	-610135.3	-619583.4	-629180.2	-638928.2	-648829.6
04	132170.54	134213.64	136288.84	138396.66	140537.62	142712.24	-387328.9	147164.64	149443.52	151758.28	154109.48	156497.71
.5	3570678.3	4067453.3	4577586.8	5188122.8	5658931.6	6229716.5	6287954.3	6897898.6	7527877.4	8175292.3	8842367.4	9528148.5
0	0	0	0	0	0	0	0	0	0	0	0	0
1	-263770.5	-250325.1	-237566.0	-225458.1	-213968.1	-203064.4	-192717.2	-182897.8	-173579.5	-164736.5	-156344.7	-148380.9
8	-212512.5	-201679.9	-191400.2	-181645.3	-172388.1	-163603.3	-292810.3	-147355.7	-139848.1	-132723.6	-125962.5	-119546.3
873	51258.815	48645.288	46165.747	43812.839	41580.889	39461.122	-108093.2	35542.185	33731.370	32012.935	30382.163	28834.575
46	378178.42	418815.62	464981.34	508794.20	550370.21	589835.33	489742.17	525284.36	559815.73	591828.66	621410.83	650245.48
0	0	0	0	0	0	0	0	0	0	0	0	0

SIMPLE PAYBACK

4.12

DISCOUNTED PAYBACK

7.74

5

DATE
ILME